CHAPTER **13**

LADDER PLATING HIGH-RISK HINDFOOT AND MIDFOOT FUSIONS

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INTRODUCTION

There are a variety of surgical indications for arthrodesis of the hindfoot and midfoot joints, including degenerative and traumatic arthritis, joint instability, and Charcot arthropathy. The joints along the medial and lateral columns are a challenge to fuse, as the architecture of the bone surfaces make compressive fixation difficult to achieve. In addition, the long lever-arm of the forefoot transfers significant force through the hindfoot and midfoot joints, which can disrupt the fusion site should inadvertent weight bearing occur prior to bony consolidation. Therefore, stable internal fixation is essential to achieve bone healing, and simple stapling or interosseous screw fixation often proves difficult and insufficient. The author will present his experience in treating difficult hindfoot and midfoot fusions via a ladder plating technique, which employs medial and lateral screw and plate fixation in order to create a metallic cage around the fusion site. The construct radiographically resembles the rails and rungs of a ladder.

SURGICAL CONSIDERATIONS

Columnar plating allows for stable fixation of square joints that are otherwise difficult to orient with crossed lag screw fixation. Tension-side plating on the plantar axis of the medial and/or lateral columns takes advantage of ground reactive forces, which act to compress through the fusion site at the dorsal aspect of the bone-bone interface (Figure 1). Unfortunately, it is often difficult to access the plantar surface of the arch due to soft tissue constraints.

Manual compression is first used to align the fusion site, which is then temporarily stabilized with oblique crossing Kirschner-wires (K-wires). Compression is achieved by eccentric-drilling and loading of the screw-plate interface. One-sided or both-sided eccentric loading can be employed to achieve the desired amount of compression and deformity correction. Conventional screw and plate applications are acceptable when utilizing the ladder plating technique, as are locking screw/plate designs. The author routinely utilizes a combination of non-locking and locking screws within the same plate. The screws closest to the fusion site are typically non–locking screws that are eccentrically drilled, thereby creating compression at the bone-bone interface. Locking screws are then used in holes distant to the fusion site to lock the construct together (Figure 2).

Newer variable-angle locking plates are now available that do not require concentric center-guided drilling to achieve locking of the screw into the plate, and as such these plates can be used to achieve compression via eccentric drilling (Figure 3). Regardless of plate choice, screw lengths are maximized to capture as much bone as possible, but not too long so as to be prominent.

The use of medial and lateral plates creates the ladder effect, however, similar stability can be afforded by orienting screws/plates at oblique angles to one another. This is particularly useful when performing adjacent Lisfranc joint arthrodeses, where a horizontally-oriented plate is placed medially over the first metatarsal-cuneiform joint, and vertically-oriented plates are used over the lateral joints (Figure 4).

Ladder plating is useful at any level of the hindfoot or midfoot, and can be utilized as part of any multi-level arthrodesis, such as a pantalar arthrodesis, triple arthrodesis, midtarsal arthroedesis, Lisfranc joint arthrodesis, or any combination thereof. Ladder plating is also useful in fixation of the midtarsal joints around a retrograde intramedullary nail, when also fusing the ankle and subtalar joints.

A variety of pathologic processes are attributed to joint collapse and instability, including degenerative arthritis (Figure 5) and Charcot arthropathy (Figure 6). Ladder plating provides a greater degree of stability than traditional screw fixation, especially in high-risk patients (obese, neuropathic, osteoporotic) that have compromised bone quality.

Figure 1A. Preoperative view of collapsed medial column with dislocated navicular-cuneiform joint.

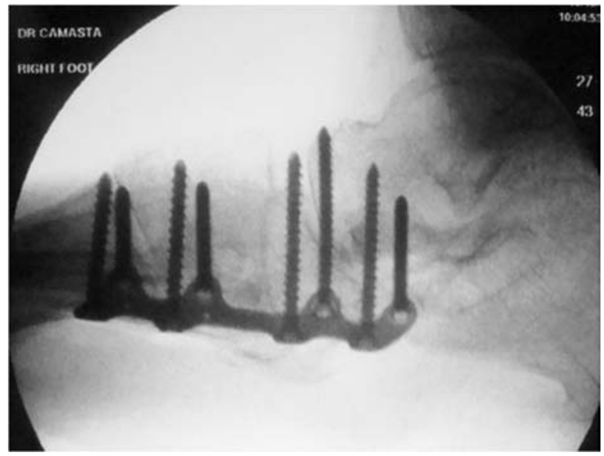

Figure 1B. Intraoperative view following tension-side plating of the medial column with fusion of the navicular-cuneiform joints and spanning of the talo-navicular and metatarsal cuneiform joints. A gastrocnemius recession was also performed to eliminate equinus contracture.

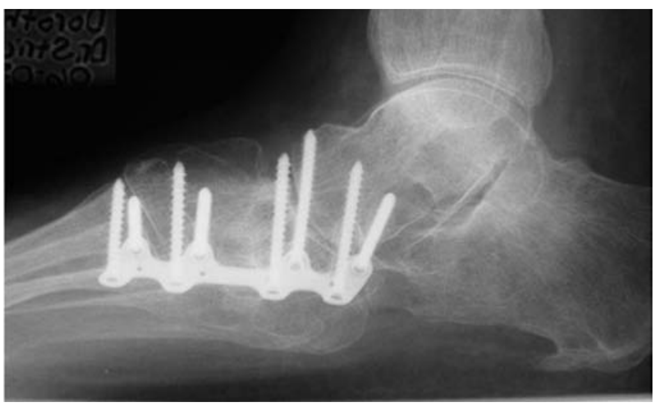

Figure 1C. One year postoperative radiograph demonstrates maintenance of arch restoration.

Figure 1D. Preoperative appearance of the medial arch.

Figure 1E. Postoperative clinical appearance of the medial arch.

Figure 2A. Ladder plating of the midtarsal joint in a patient with an ankle + triple arthrodesis utilizing an intramedullary nail to stabilize the hindfoot & ankle. Note the use of non-locking screws adjacent to the fusion sites, which are eccentrically placed to compress the fusion sites, and the use of locking screws distal and proximal to the fusion sites, which enhances screw/plate/bone stability.

Figure 2B. Lateral view of ladder plating.

Figure 3A. Lateral stabilization of a triple arthrodesis calcaneo-cuboid fusion site is initially achieved via manual compression and crossed K-wire fixation.

Figure 3B. Use of a variable-angle locking plate allows for eccentric drilling on both sides of the fusion site to achieve maximum compression.

Figure 3C. The screws are placed prior to final "landing" and are subsequently locked into the plate.

Figure 3D. The remaining holes are filled with locking screws.

Figure 3E. Medial fixation of the talo-navicular joint included the use of an interfragmentary compression 6.5 mm screw as well as a locking plate.

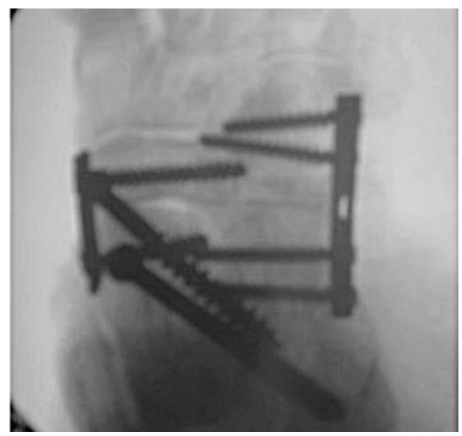

Figure 3F. Radiographic DP view of the ladder effect at the time of surgery with DP.

Figure 3G. Lateral view at the time of surgery.

Figure 4A. Preoperative lateral view of medial and dorsal plating of the midfoot in a diabetic Charcot foot.

Figure 4B. Postoperative lateral view demonstrating reduction of the deformity and adequate bone consolidation.

Figure 4C. Preoperative dorsal-plantar radiograph.

Figure 4D. Postoperative view demonstrating transverse plane reduction of the midfoot deformity.

Figure 5A. Preoperative view of collapsed, unstable medial column with dislocation of the Lisfranc joint secondary to traumatic arthritis, and adaptive equinus contracture.

Figure 5B. View after surgical correction.

Figure 5C. Lateral radiograph before fusion.

Figure 5D. Lateral view post-fusion of the Lisfranc and navicular-cuneiform joints utilizing the ladder plate technique.

Figure 5E. Preoperative dorsal-plantar film.

Figure 5F. Postoperative view demonstrates significant deformity correction.

Figure 6A. Ladder plating the midfoot and hindfoot in a diabetic Charcot foot with significant joint dislocation of the midtarsal and Lisfranc joints. High-risk patients benefit from the enhanced strength and stability of medial and lateral plating. Preoperative dorsal-plantar radiograph.

Figure 6B. Postoperative view demonstrating anatomic reduction through the arthrodesis sites.

Figure 6C. Preoperative lateral radiograph.

Figure 6D. Postoperative view demonstrating restoration of the arch alignment and adequate bony consolidation.